## Predicting Behavior Development and Academic Achievement: The Interplay between Cognitive Functioning and Social Relationships

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# Chapter 5

## Cognitive Impulsivity and Delinquency from Late Childhood to Early Adulthood: Moderating Effects of Parenting Behavior and Peer Relationships

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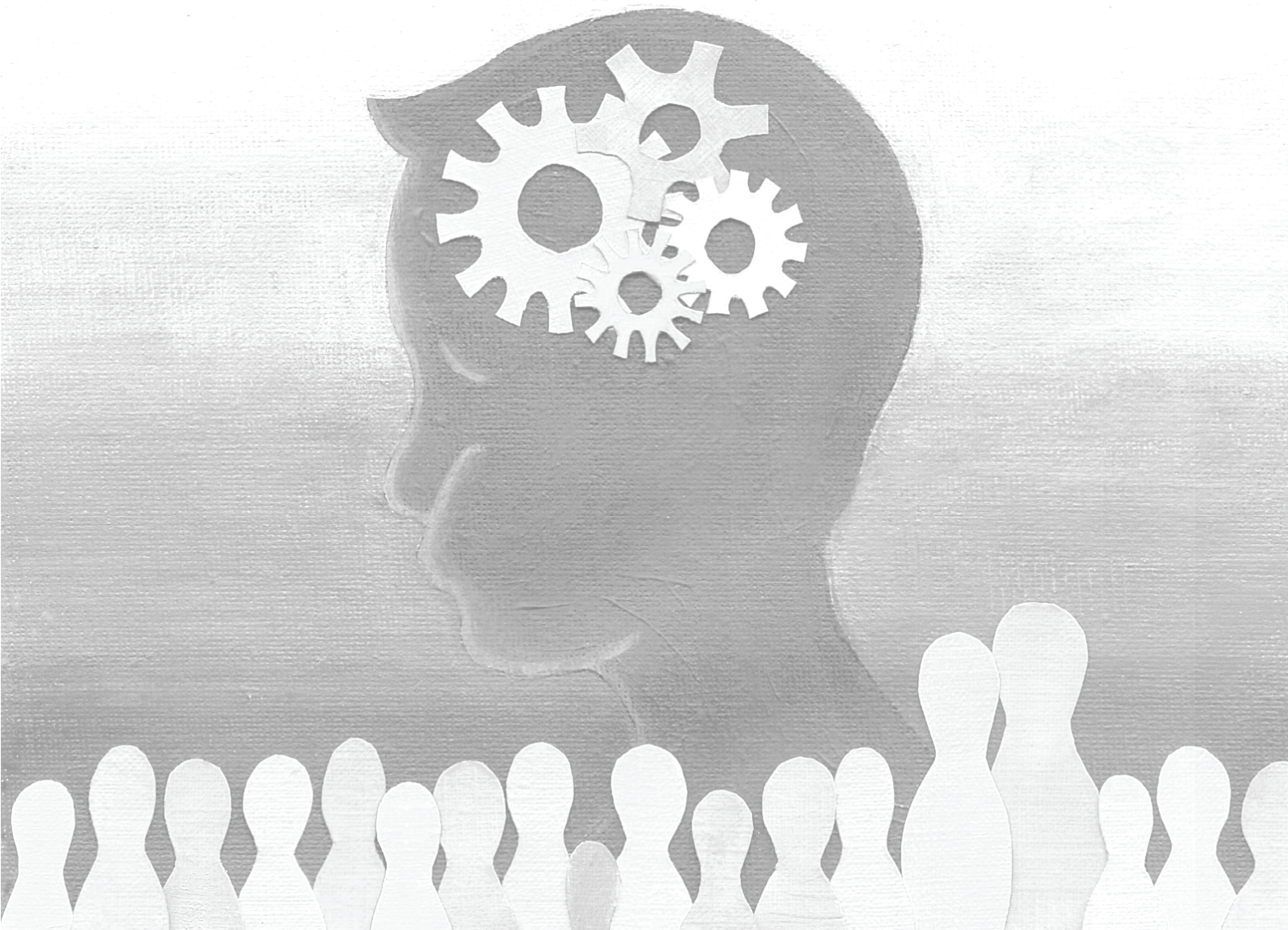


**Abstract**

Children who are cognitively impulsive are described to be at risk of developing delinquent behavior. However, the influence of cognitive impulsivity may depend on social environmental risk factors. In this study we aimed to examine whether the influence of children's cognitive impulsivity on the course of delinquency covering adolescence and early adulthood was moderated by parenting behaviors and the relations with peers in late childhood. Delinquent behavior of 422 boys from the Pittsburgh Youth Study was measured with official arrest records, obtained over ages 11 to 29 years. Cognitive impulsivity was assessed with neurocognitive tests at age 12/13. Parenting behaviors (persistence of discipline, positive reinforcement, and parental knowledge) were assessed using parent and child reports. Child reports on the number of peers engaging in delinquency and on conventional activities of peers were used. Results showed that the influence of cognitive impulsivity on the probability of showing delinquent behavior depended on parenting behaviors and peer delinquency. Specifically, in the absence of poor parenting or peer delinquency, cognitive impulsivity predicted delinquency from age 11 to 29. In the presence of poor parenting or peer delinquency, cognitive impulsivity did not increase the probability of being delinquent. Results thus underscore that to understand the influence of neurocognitive risks on children's delinquent behavior development, we need to take the social context in which these children live into account. Implications for research and interventions are discussed.

## Introduction

Delinquent behavior is most prevalent during adolescence, as clearly depicted by the peak of the age-crime curve around age 17, followed by a decline in prevalence in adulthood (Blumstein, Cohen, Roth, & Visher, 1986; Farrington, 1986). This peak may be accounted for by the delinquent behavior of two sub-populations: those who already showed signs of antisocial tendencies during childhood, and those who start offending only from adolescence onward. Although the number of youths in the latter group (adolescent onset offenders) is larger than of those who already show antisocial behavior in childhood, it is important to note that this first group (early starters; cf. Moffitt, 1993) will likely also show a peak in offending during adolescence (Wiesner, Capaldi, & Kim, 2007), and will account for a disproportionally high percentage of offences committed in adolescence and young adulthood (Moffitt, Caspi, Harrington, & Milne, 2002). Given the consequences of delinquency, both at the individual or societal level (Molero Samuelson, Hodgins, Larsson, Larm, & Tengström, 2010; Welsh et al., 2008), it is crucial to identify risk factors that predict the course of offending in adolescence and early adulthood especially among early starters.

In the search for factors underlying the development of delinquency, emphasis has been put on neuropsychological deficits (particularly those associated with frontal lobe dysfunction), such as cognitive impulsivity, which includes problems with adaptively shifting

between cognitive sets, disinhibition, acting without thinking/rapid cognitive tempo, and poor self-control and attention (White et al., 1994). Such neuropsychological deficits have been theorized to especially affect the development of delinquent behavior among boys who show behavior problems early in their development (Moffitt, 1993). It is important to note, however, that in addition to their possible cognitive vulnerabilities, social environmental risk factors are also thought to add to the development of delinquent behavior in these boys. Particularly inadequate parenting behavior and boys' engagement with deviant peers have been pointed to as important social risk factors (Loeber, 1990; Moffitt, 1993; Rubin, Bukowski, & Parker, 2006; Rutter, 2003). In fact, the early starter model poses that cognitive impulsivity expresses itself in the context of an at-risk social environment, resulting in more and persistent delinquent behavior (Moffitt, 1993). Moffitt and colleagues (2002) demonstrated that childhood-onset delinquents (i.e., mainly boys with increased cognitive and environmental risk) were indeed the ones showing most delinquent behavior at age 26 (Moffitt et al., 2002). However, these authors did not investigate the possible amplification of effects of impulsivity on delinquency by parent and peer factors. In this study, we aimed to test this hypothesis. Using an at-risk sample in which children with signs of antisocial behavior at or around age 10 years were oversampled, we studied the predictive association of cognitive impulsivity with the course of arrests, as an indicator of delinquency, over the period from age 11 to 29 years, in the context of parenting behaviors (parental discipline, positive reinforcement, parental knowledge) and peer relational factors (peer delinquency, peer conventional activities).

Associations have indeed been found between measures of cognitive impulsivity (e.g., set shifting, inhibition, cognitive tempo), and delinquent behavior in adolescence and adulthood (Carroll et al., 2006; Morgan & Lilienfeld, 2000; Ogilvie, Stewart, Chan, & Sum, 2011). Moreover, there is evidence for predictive links from childhood assessed cognitive functions to future delinquency (Moffitt, Caspi, Rutter, & Silva, 2001; Moffitt, Lynam, & Silva, 1994). Deficits in such cognitive functions are suggested to hamper youth to control their behavior, to learn, recognize and understand social norms and laws, and to foresee consequences of delinquent acts, thereby increasing the risk of showing delinquent behavior (Ishikawa & Raine, 2003; Moffitt, 1993; Nigg & Huang-Pollock, 2003).

Both parenting behaviors and peer relationships may also play a role in the development of delinquent behavior (Dodge & Pettit, 2003; Loeber & Hay, 1997), particularly in late childhood/early adolescence, the period in which youngsters start to spend less time with their parents in their search for autonomy (Larson, Richards, Moneta, Holmbeck, & Duckett, 1996) and more time with peers (Rubin et al., 2006). Parenting behaviors such as parental supervision or knowledge of the youth's whereabouts, persistence of discipline and parental support/reinforcement may all affect the child at the risk of being delinquent during this transitional period (Hoeve et al., 2009; Loeber & Stouthamer-Loeber, 1986). With respect to peer relationships, particularly affiliation with delinquent peers

strongly predicted delinquency (Deater-Deckard, 2001; Matsueda & Anderson, 1998). This link likely results from a process in which delinquent behaviors are learned from and reinforced by these delinquent peers (i.e., deviancy training; Dishion, Spracklen, Andrews, & Patterson, 1996).

However, the effect of cognitive and social environmental risks is likely not solely additive, but may very well be interactive (Farrington & Ttofi, 2011; Moffitt, 1993). That is, the risk that boys with higher cognitive impulsivity follow a delinquent developmental pathway might be disproportionally larger in an at-risk social environment. For example, an at-risk environment may fail to provide the external control these children likely need to compensate for their weaker internal regulatory competences (Henry, Caspi, Moffitt, & Silva, 1996; Lynam et al., 2000). In other words, when parenting is poor (e.g., when proper parental knowledge/supervision, consistent discipline and positive reinforcement by parents are lacking), the likelihood that cognitive impulsivity increases the probability of being arrested may become especially apparent, because there is no proper parental control to compensate for the increased cognitive risk. Prosocial activities with mainstream peers may similarly provide the external social control that these vulnerable boys need (e.g., by reducing unstructured time; Booth, Farrell, & Varano, 2008), thus decreasing their risk of being arrested. By contrast, affiliations with delinquent peers may disproportionally increase their risk of being arrested, because their higher impulsivity may make them more susceptible to negative peer influences (Grosbras et al., 2007).

There is empirical evidence supporting the theorized interaction between (neuro)cognitive variables and social environmental risk variables. Impulsive boys (impulsivity measured with behavioral reports and cognitive tests) have been found to be most delinquent in disadvantaged neighborhoods, whereas impulsivity had little effect on delinquency in better neighborhoods (Lynam et al., 2000). Similarly, boys with lower neuropsychological test scores raised in an adverse home environment were disproportionally more likely to be aggressive than boys with either a cognitive or environmental risk (Moffitt, 1993). Moreover, genetic risk was found to be a stronger predictor of externalizing disorders at higher levels of peer delinquency, but also at lower levels of affiliation with prosocial peers (Hicks, South, Dirago, Iacono, & McGue, 2009). These findings may also apply to effects of cognitive impulsivity on delinquency in the context of parenting behavior and peer relational variables.

In sum, this study examined whether the effect of cognitive impulsivity on the probability of being arrested between age 11 and 29 depends on parenting behavior (i.e., persistence of discipline, positive reinforcement, and parental knowledge) and on peer relationships (peer delinquency and conventional activities of peers). We hypothesized that both parenting behavior and peer relational factors would moderate the association between cognitive impulsivity and the prevalence of delinquency from late childhood onwards. More

specifically, we hypothesized the risk of being arrested to be highest in boys exposed to both cognitive and social environmental risks.

## Methods

*Participants*

Participants were from the middle sample of the Pittsburgh Youth Study (PYS; for details see Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998b). From a pool of all eligible fourth grade boys in participating public elementary schools in 1987-1988, 1,146 were randomly selected for potential participation in the screening. A follow-up sample was selected using the screening risk score of the boys' antisocial behavior measured with parent, teacher and self-report instruments. All boys within the upper 30% risk scores were selected for follow-up ($N = 259$, ≈ 50%) along with a roughly equal number of boys selected from the lower 70% of the distribution ($N = 249$, ≈ 50%), resulting in a total sample of 508 boys. The mean age of the sample was 10.2 years ($SD = 0.76$) at screening, with an ethnic composition of 42.7% Caucasian, 52.4% African-American, 4.9% other (similar to the screening sample). Informed consent was obtained from all participants.

For 422 boys (83.1% of the total sample), scores were available on all three tests of cognitive impulsivity used in this study. These 422 boys did not differ from the total 508 sample on ethnicity or screening risk status ($p$'s > .05), but boys without cognitive impulsivity data had lower mean SES scores ($F(1,506) = 6.77$, $p = .01$). Criminal record information was collected for all participants until age 29. Of these 422 participants, 13 died at some point during the follow up (age range 14 to 29). These 13 participants did not differ on screening risk status or ethnicity. However, they had on average lower SES scores ($F(1,420) = 3.87$, $p = .05$). For all other participants, arrest records were available at every age.

*Measures*

*Official arrest records* from age 11 to 29 were obtained via local, state and federal sources (Loeber, Farrington, Stouthamer-Loeber, & White, 2008). Participants with at least one charge for any type of offence (e.g., murder, rape, robbery, fraud, theft, drug possession, traffic violation) at a particular age year received the score 1 and participants without any charge received the score 0.

*Measures of Cognitive Impulsivity (CI)*

An overall index of cognitive impulsivity was constructed using scores on The Trail Making Test, the Stroop Color and Word Association Test, and Time Perception. These measures were administered at the university during the summer of 1990, when the boys were on average 12.73 years old ($SD = 0.87$, range = 10.75 to 16.08). The 90-minute laboratory session was conducted by three full-time rigorously trained examiners, who were

unaware of the boy's risk status and potential prior police contacts. Tasks were assessed in two blocks of 45 minutes and in the same order because a similar motivational set was required at the beginning of each task for each boy. For the cognitive impulsivity measure, the three tests with the highest factor loadings in the cognitive impulsivity construct described by White and colleagues (1994) were selected.

*The Trail Making Test* measures the ability to initiate, switch, and stop a sequence of complex purposive behaviors, requiring attention and concentration skills. After drawing lines between consecutively numbered circles (Form A), the participants had to draw lines between consecutive numbers and letters (Form B), switching between the two sequences (i.e., A to 1 to B to 2 to C, etc.). Scores used were the time needed for Form B minus the time needed for Form A (White et al., 1994), with $M = 18.37$, $SD = 15.22$, ranging from -36 to 87.

*The Stroop Color and Word Association Test* tests the ability to inhibit an automatic overlearned response and generate a competing new response instead (Dodrill, 1978; Stroop, 1935), requiring sustained attention and mental control. In the first trial participants had to read color names, followed by the inhibition trial, where participants were asked not to read the name of the color, but instead name the different color of the ink in which the words were printed (suppressing reading the color names). The number of errors in the inhibition trial was used in this study, because the time needed to finish the card and the number of errors were highly correlated, and the error score was more normally distributed (White et al., 1994), with $M = 9.19$, $SD = 5.72$, ranging from 0 to 48.

*Time Perception* was measured with time estimation and time production tasks, measuring cognitive tempo (White et al., 1994). In time estimation, the stopwatch was run for seven consecutive intervals of 2, 2, 4, 4, 12, 25 and 60 seconds in this study. Participants had to estimate after each interval how many seconds had passed. In time production, participants had to indicate when they thought 2, 2, 4, 4, 12, 25 and 60 seconds had passed. Time estimation and reflected time production scores ($r = -.54$) were summed (see White et al., 1994), with scores ranging from 44 to 849.6, and $M = 212.1$, $SD = 85.76$. The three tests were significantly associated ($r$ ranged from .15 to .27). To obtain a total cognitive impulsivity score, scores were standardized and summed (positive scores indicated higher cognitive impulsivity, and negative scores lower cognitive impulsivity), which was standardized once more within the sample of 422 boys.

Overall, it was found that boys who showed most behavioral problems at screening (i.e., at-risk; half of the sample) had poorer scores on the cognitively impulsivity tests than the boys who were not considered to be at increased risk ($F(1, 420) = 13.96$, $p < .001$).

*Parenting Behavior Variables*

Three parenting behavior variables were used in this study, assessed with questionnaires, verbally administered to the primary caretaker (mostly the boys' mother (87.4%), then father (4.5%), grandmother (4.4%), or otherwise related to the child), and the

boys every six months, for six consecutive assessment points after the screening (average age is 10.8 at first assessment, and 13.3 years at last assessment) (Loeber et al., 2008). A multiple informant score (parent and boy) over multiple assessments was used. Before item scores in each scale were summed, all items where a higher score represented poor parenting behavior were reversed before being summed so that higher total scores represented better parenting behavior (or a lower risk). First, the mean of parent and child scores was calculated for each of the six assessment points, after the scale range for parent and child was made equal by dividing the sum score by the number of items in the scale. Scores were coded missing if parent and/or child data were not available at a particular assessment point. Subsequently, a mean score was calculated of these parent/child combined scores across all available time points for each boy. These mean scores were standardized. Almost all boys had both a parent and a child score at at least three assessment points for each parenting variable (99.1-99.5% of the boys), and none of the boys had missing data on all occasions for any of the three variables.

*Persistence of discipline* consisted of four items for both parent and child, measuring the degree to which the parent persisted in disciplinary action toward the boy (e.g., parent: *"Do you let your son get away with things?"*; boy: *"If your mother had planned some punishment for you, could you talk her out of it?"*; Loeber et al., 1998b), using a 3-point Likert scale (1 = "almost never"; 2 = "sometimes"; 3 = "almost always"). Some items were reversed so that high scores represented persistent parental discipline. Cronbach's alpha ranged from .49 to .66 for the parent, and from .54 to .64 for the child scale across the six assessments. To make a more robust persistence of discipline score, scores across the six assessments were used; all correlations between the six assessments were significant for both informants (parent: $r$ ranged from .41 to .64; child: $r$ ranged from .29 to .49). Moreover, the parent and child score (mean of six assessment points) correlated significantly ($r$ = .22, $p$ < .001).

*Positive reinforcement* was measured with the Positive Parenting Scale (Loeber et al., 1998b), asking the parent and boy how often the parent provided the boy with positive reinforcement when the boy has done something well (e.g., *"When your son/you did something that you/your mother liked or approved of, how often did you/does she give him/you a wink or smile?"*), using a 3-point Likert scale (1 = "almost never"; 2 = "sometimes"; 3 = "often"). The scale consisted of eight items for the parent, and seven for the boy. Cronbach's alpha was .74-.79 for the parent, and .75-.88 for the child across the six assessments. Correlations ranged from .39-.62 between the six parent assessments, and .30-.55 between the six child assessments. The parent and child score correlated significantly ($r$ = .28, $p$ < .001).

*Parental knowledge* was measured with four items of the Supervision/Involvement measure (Loeber et al., 1998b). Items include: *"When your son is/you are out, do you/do your parent(s) know what time he/you will be home?"*, using a 3-point Likert scale

(1 = “almost never”; 2 = “sometimes”; 3 = “almost always”). Cronbach’s alpha was .50-.64 for the parent, and .53-.70 for the child scale across the six assessments. Correlations ranged from .32-.60 between the six parent assessments, and .28-.55 between the six child assessments. The correlation between the parent and child score was .35 ($p < .001$).

*Peer Relational Variables*

The two peer relational variables used in this study were measured with questionnaires verbally administered to the boys only, every six months (peer delinquency; six assessments points, first on average at 10.8, last at 13.3 years) or every year (conventional activities with peers; three assessments points $M$ = 10.8, 11.8, and 12.8 years). A mean score across all available time points was calculated for both peer relation variables (with peer delinquency scores available from at least three measurements for all boys, and conventional activities at least two out of three assessments for 99% of the boys), which was standardized.

*Peer delinquency* was measured with nine items, asking how many of the boy’s friends were delinquent (e.g., theft, violence, and property damage; see Loeber et al., 2008) in the past six months (ranging from none = 0, to all of them = 4). Cronbach’s alpha ranged from .82 to .90 across the six assessments. Cronbach’s alpha was .83 for the six scale scores at each of the assessment points. Correlations ranged from .34-.59 between the six assessments. High scores indicate high peer delinquency.

*Conventional activities of peers* was measured with eight items, asking the boys how many of their friends have been involved in conventional activities, such as school athletics or family activities, or whether they are good students (Loeber et al., 1998b). Cronbach’s alpha ranged from .71 to .80 across the three assessments. Correlations ranged from .26-.43 between the three assessments. High scores represent having many friends involved in multiple conventional activities.

*Ethnicity, test age, SES, IQ, and convictions* were used as control variables. Because participants were primarily Caucasian or African-American (95.9%), ethnicity was dichotomized into African-American (score = 1) or Caucasian and other ethnic backgrounds (score = 0; see Pardini, Fite, & Burke, 2008). Test age was participants’ age at the time the cognitive tests were conducted (summer 1990). SES was the mean of the available SES scores from seven semi-annual assessments (screening, and the six consecutive assessment points), based on Hollingshead’s (1975) index. IQ was measured in the same test session as the cognitive impulsivity tests. A short form (i.e., shortened versions of all ten subtests) of the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974) was used. IQ was negatively correlated with cognitive impulsivity ($r$ = -.51). Information on convictions was obtained with official records, comparable to the method for arrests (Loeber et al., 2008). Convictions (also dichotomized for each age year) were used as a proxy of incarceration to control for the possibility that cognitively vulnerable early starters were more often incarcerated which may artificially reduce the risk of being arrested again.

*Statistical Analyses*

Data were analyzed with logistic population-averaged generalized estimating equation (GEE) models, using STATA version 10 (StataCorp, 2007). GEE models account for non-independent observations on dependent variables, such as repeated measures over time. In this study, the association between the dependent variables over time was modeled using an autoregressive correlation structure. This model assumes that the association between arrest outcomes measured at different ages decreases as the temporal separation between the assessments increases in systematic manner (Shults et al., 2009). Standard errors that are robust to potential misspecification of dependent variable correlation structure were also used (Zeger, Liang, & Albert, 1988).

Developmental change in the percentage of boys being arrested was modeled across time by entering age, age squared ($age^2$) and age cubed ($age^3$) as predictors into the model. Subsequently, main effects of CI were tested in a model with age, $age^2$ and $age^3$, while controlling for ethnicity, test age, and SES. Examination of moderation by parenting/peer relational variables was performed in three steps. In the first step, the main effects of CI combined with each of the parenting behavior and peer relational variables were tested by adding them to the model with the three age variables, the three control variables, as well as IQ (because IQ interacted with CI in the prediction of arrests; cf. Loeber et al., in press). In the second step, interaction terms between CI and each of the five parenting and peer relational variables were also added to the models from the first step, in order to test whether the effect of CI on the arrest probability is moderated by parenting/peer relational factors. In the third step, significant interaction terms were probed to examine the direction of the moderation by manipulating the 0 point for one of the variables (i.e., the parenting/peer relational variables) (Holmbeck, 2002), and then estimating the effects of CI in the model with parenting/peer relational $variable_{high}$ (equals zero when the relational variable is $M + 1SD$) and in the model with parenting/peer relational $variable_{low}$ (equals zero when the relational variable is $M - 1SD$).

## Results

*Descriptive Statistics*

Seventy-two percent of the participants were arrested at least once between age 11-29 (*Mdn* = 7 arrests). The proportion of participants that was arrested at least once in each age year (11-29) is presented in Figure 5.1. It shows increases during adolescence, followed by a decrease in early adulthood. The correlations between cognitive impulsivity (CI) and the parenting behavior and peer relational variables are presented in Table 5.1. It shows significant correlations between CI and parental knowledge and peer delinquency; the correlations between CI and persistence of discipline, positive reinforcement and conventional activities with peers were non-significant. Correlations between the parenting

behavior and peer relational variables were in the expected direction, except the correlation between positive parenting and peer delinquency, which was non-significant.

Note that arrests were assessed from ages 11 onwards. Consequently, arrests, especially when followed by convictions, may have impacted the assessment of parenting behaviors and peer relationships, which were assessed up till age 13.3 (on average). We therefore compared whether changes in parenting and peers scores between age 10.8 (*M* age at first assessment, prior to first assessment of arrests) and ages 11.3-13.3 (*M* age at five subsequent assessments) were different for participants who were arrested between age 11 and 13 ($n$ = 90) compared to those who were not arrested ($n$ = 332). No significant differences were found for persistence of discipline ($F(1,412) = 1.81$, $p = .18$), positive reinforcement ($F(1,417) = 1.12$, $p = .29$), and peer delinquency ($F(1,388) = 0.01$, $p = .94$), implying that being arrested between age 11-13 (and possible subsequent convictions) did not impact the assessments of these parenting behaviors or peer relationships. However, change in parental knowledge ($F(1,406) = 3.89$, $p = .05$) and conventional activities of peers ($F(1,405) = 3.86$, $p = .05$) were significant, although the effect sizes were in the low range (respectively 0.23 and 0.24; Cohen, 1988). Being arrested may thus have affected the assessment of parental knowledge and conventional activities of peers to some extent.

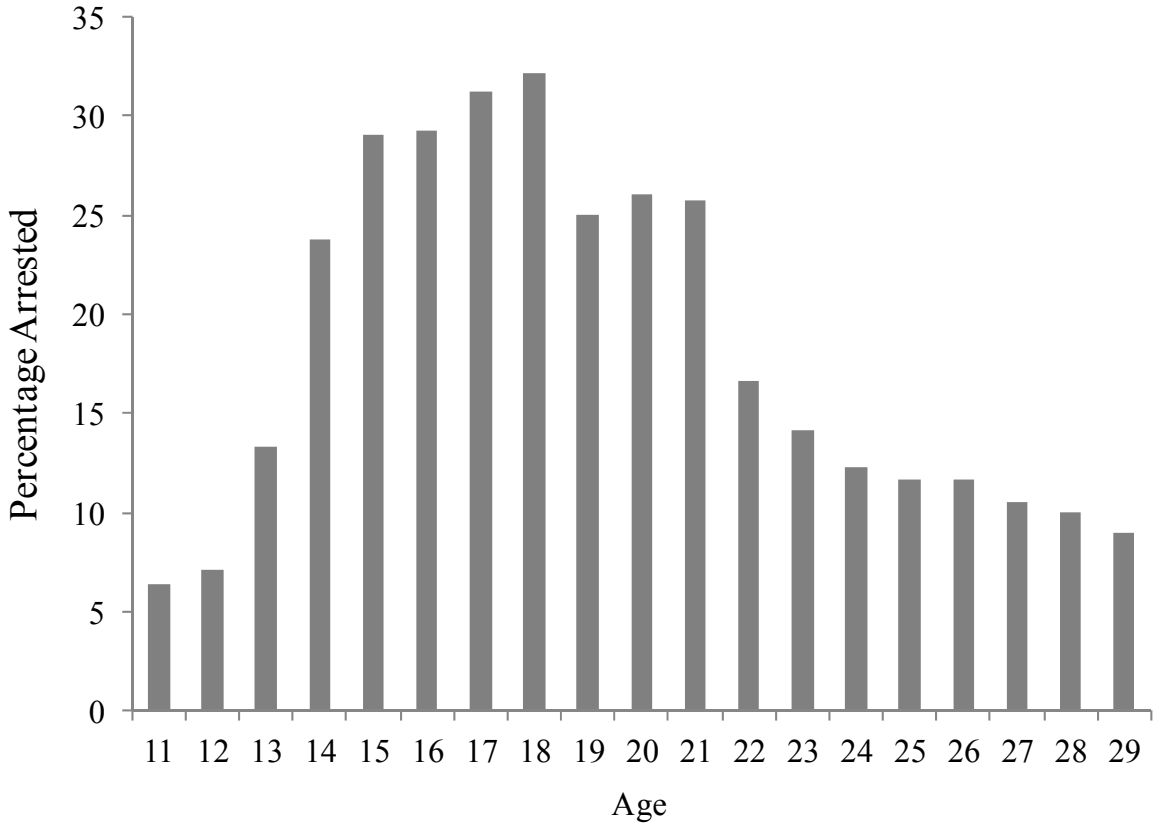



*Figure 5.1*. Observed percentages of participants arrested at least once in each age year (age 11-29).

Table 5.1

*Correlations Between Cognitive Impulsivity and Parenting Behavior and Peer Relational Variables*

| Variable | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|
| 1. Cognitive Impulsivity | — | | | | | |
| 2. Persistence of Discipline | -.08 | — | | | | |
| 3. Positive Reinforcement | -.08 | .10* | — | | | |
| 4. Parental Knowledge | -.20** | .29** | .42** | — | | |
| 5. Peer Delinquency | .18** | -.17** | -.05 | -.42** | — | |
| 6. Conventional Activities of Peers | .01 | .10* | .29** | .30** | -.19** | — |

* $p < .05$. ** $p < .01$.

*Cognitive Impulsivity, Parenting and Peers and the Development of Arrests Across Adolescence and Adulthood*

To mirror the observed age-arrest curve (increases in arrests in early-mid adolescence, followed by a decrease in late adolescence/early adulthood, and stabilization in adulthood) a linear, quadratic and cubic term (age, age$^2$ and age$^3$) were entered in the GEE model as predictors of the probability of being arrested. Age ($B$ = 3.89, $SE$ = 0.39), age$^2$ ($B$ = -0.19, $SE$ = 0.02) as well as age$^3$ ($B$ = 0.0028, $SE$ = 0.0003) were significant predictors ($p$'s < .001) of arrests. When CI was added to the model, it significantly predicted the probability of being arrested ($B$ = 0.15, $SE$ = 0.07, $OR$ = 1.16, $p$ = .03).

We then fitted five separate models in which cognitive impulsivity and one of the parenting behavior and peer relational variables were added together with age, age$^2$, age$^3$, while controlling for ethnicity, test age, SES and IQ scores. In the first step, CI and the parenting/peer variables were added as main effects only. In the second step, the interaction term between cognitive impulsivity and the parenting/peer variable was added to the model. Results in Table 5.2 show significant interaction terms between CI and the three parenting variables, and between CI and peer delinquency in the prediction of probability of being arrested. The interaction term between CI and conventional activities of peers was not significant.

Table 5.2

*Interaction Between Cognitive Impulsivity (CI) and Parenting Behavior and Peer Relational Variables*

| | Probability of Being Arrested | | |
|---|---|---|---|
| | *B* | *SE* | *OR* |
| **CI and Parenting Behavior** | | | |
| Persistence of Discipline | | | |
| *Step 1* | | | |
| CI | 0.06 | 0.07 | 1.06 |
| Persistence of Discipline | -0.07 | 0.06 | 0.93 |
| *Step 2* | | | |
| CI | 0.07 | 0.07 | 1.07 |
| Persistence of Discipline | -0.09 | 0.06 | 0.91 |
| CI×Persistence of Discipline | 0.12* | 0.07 | 1.13 |
| Positive Reinforcement | | | |
| *Step 1* | | | |
| CI | 0.05 | 0.07 | 1.05 |
| Positive Reinforcement | -0.06 | 0.06 | 0.94 |
| *Step 2* | | | |
| CI | 0.08 | 0.06 | 1.09 |
| Positive Reinforcement | -0.09 | 0.06 | 0.92 |
| CI×Positive Reinforcement | 0.16** | 0.06 | 1.17 |
| Parental Knowledge | | | |
| *Step 1* | | | |
| CI | 0.05 | 0.07 | 1.05 |
| Parental Knowledge | -0.30** | 0.06 | 0.74 |
| *Step 2* | | | |
| CI | 0.14* | 0.07 | 1.15 |
| Parental Knowledge | -0.34** | 0.06 | 0.71 |
| CI×Parental Knowledge | 0.20** | 0.05 | 1.22 |

Table 5.2. Continued

| | Probability of Being Arrested | | |
|---|---|---|---|
| | *B* | *SE* | *OR* |
| **CI and Peer Relationships** | | | |
| Peer Delinquency | | | |
| *Step 1* | | | |
| CI | 0.06 | 0.07 | 1.06 |
| Peer Delinquency | 0.29** | 0.05 | 1.34 |
| *Step 2* | | | |
| CI | 0.09 | 0.07 | 1.09 |
| Peer Delinquency | 0.33** | 0.05 | 1.39 |
| CI×Peer Delinquency | -0.09* | 0.04 | 0.92 |
| Conventional Activities of Peers | | | |
| *Step 1* | | | |
| CI | 0.05 | 0.07 | 1.06 |
| Conventional Activities of Peers | 0.02 | 0.06 | 1.02 |
| *Step 2* | | | |
| CI | 0.05 | 0.07 | 1.06 |
| Conventional Activities of Peers | 0.02 | 0.06 | 1.02 |
| CI×Conventional Activities of Peers | -0.00 | 0.06 | 1.00 |

* $p < .05$. ** $p < .01$.

To decompose the significant interaction terms, we probed the interaction term by estimating the effects of CI in the model in which the parenting behavior/peer relational variable was high ($M + SD$) and in which parenting behavior/peer relational variable was low ($M - SD$). The effect of CI was plotted in both parenting behavior/peer relational conditions. Results are in Figure 5.2.

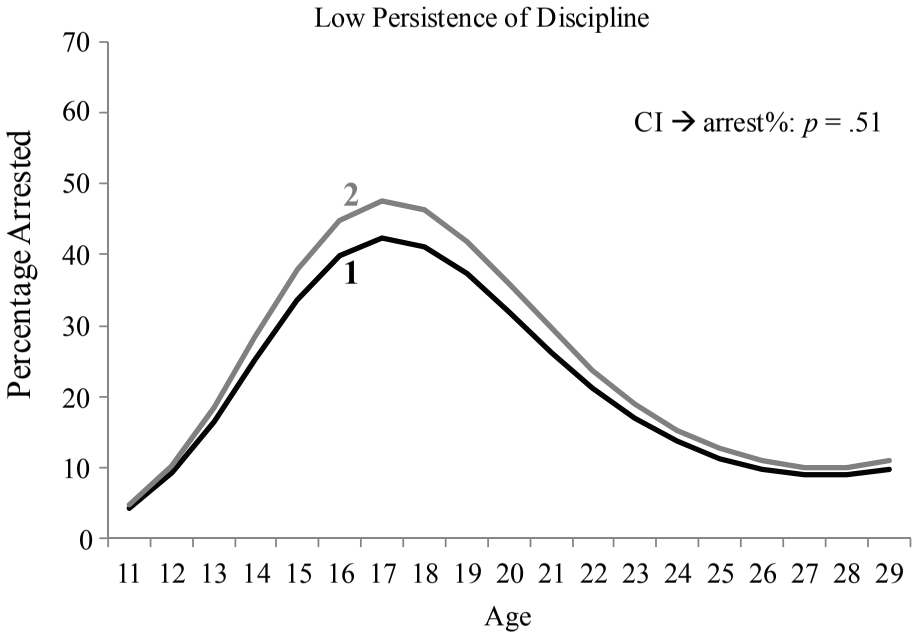
The results showed a number of findings. First, across the parenting and peer factors, we found that CI only significantly predicted the probability of being arrested in the *absence* of risk from the parenting or peer factor (comparing curves 3 and 4 in Figure 5.2). Specifically, when persistence of discipline, positive reinforcement and parental knowledge were high, and peer delinquency was low (i.e., low risk end), children low on cognitive impulsivity showed the lowest probability of being arrested across age 11 to 29 years.

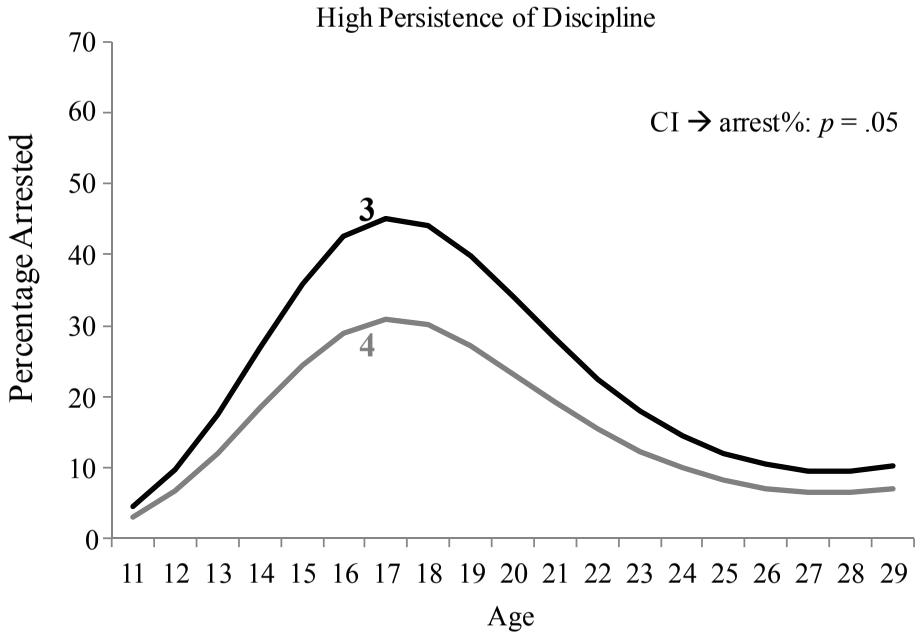
Second, again across all parenting domains and peer delinquency, it was found that in the *presence* of the social environmental risk, the impact of CI was not significant (comparing curves 1 and 2 in Figures 5.2). That is, when persistence of discipline, positive reinforcement and parental knowledge were low, and peer delinquency was high, CI did not significantly predict arrest probability. Note however that the absence of a predictive effect of CI in the at-risk environment could be explained by incarceration. That is, cognitively

vulnerable early starters may be more often incarcerated, which may artificially lower their probability of future arrests. To test for this, we examined whether the total number of years in with a participant was convicted for a violent offence, as a proxy of incarceration, differed between the high/low CI participants in the at risk environment (divided by split mean). Results showed that participants with high vs. low CI in the high risk environment did not differ on their number of years of being convicted for a violent offence (results available upon request). This suggests that it is unlikely that incarceration explained the absence of an additive effect of CI in the at-risk environment.

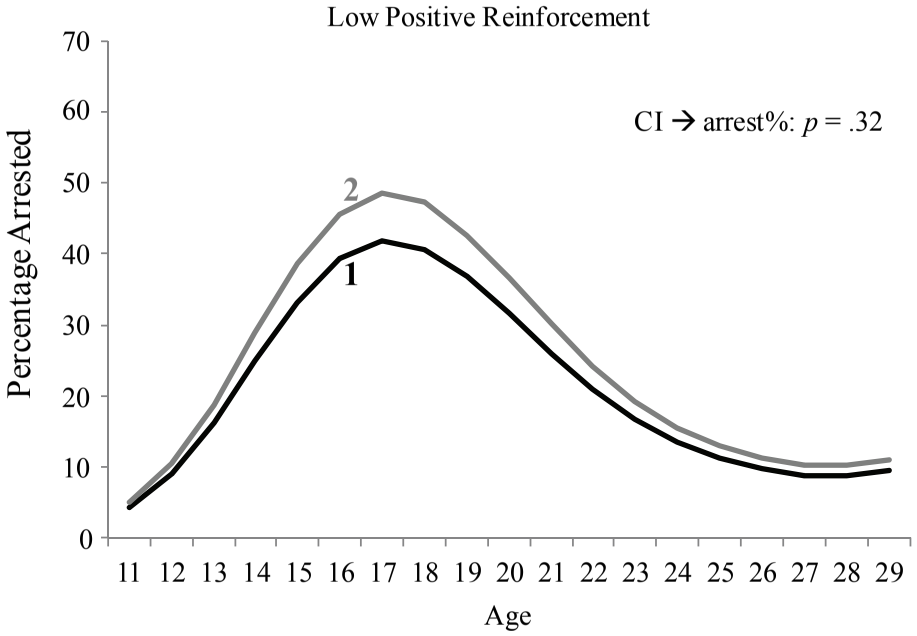
Third, in the presence of the *cognitive risk*, not all parenting/peer variables had an additive effect on the probability of arrests. That is, when CI was high, persistence of discipline and positive reinforcement did not significantly predict the probability of being arrested (persistence of discipline: $p = .71$; positive reinforcement: $p = .39$). This is illustrated by comparing curves 3 and 1 in Figure 5.2a and b, which shows the arrest curve of high CI boys with high persistence of discipline and high positive reinforcement (curve 3) (i.e., absence of parenting risk) did not differ from high CI boys in the presence of these parenting risks (curve 1). This suggests that only low CI boys benefitted from high persistence of discipline and positive reinforcement from their parents. In contrast, parental knowledge ($p = .04$) and peer delinquency ($p < .01$) were significant predictors in high CI boys (see Figure 5.2c and d): high CI boys (curve 3) who experienced high parental knowledge and who affiliated with few delinquent peers were less often arrested than high CI boys who experienced low parental knowledge and who affiliated with more delinquent peers (curve 1). Both low and high CI boys thus seemed to profit from high parental knowledge and low peer delinquency, and this effect was strongest for low CI boys.

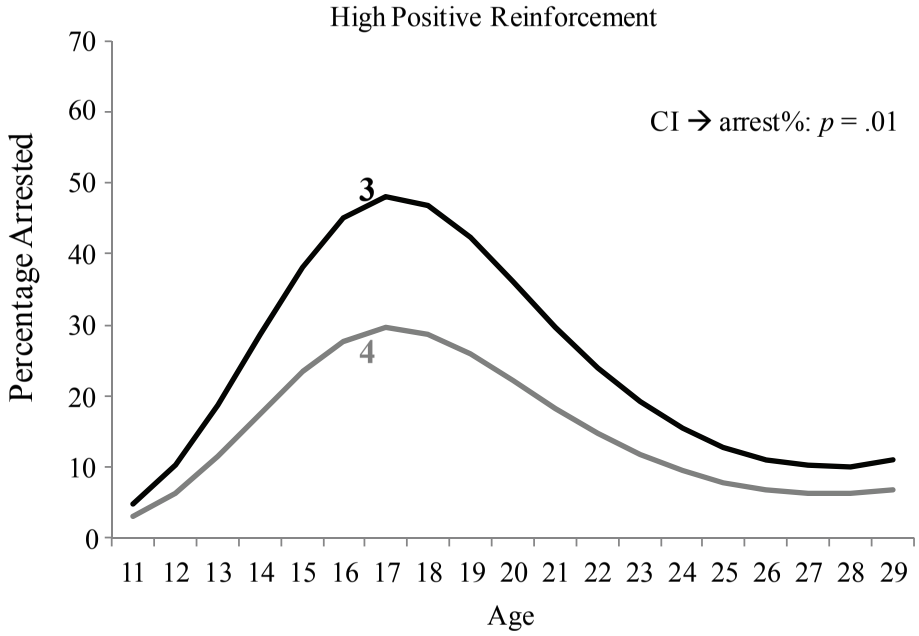
a. Persistence of Discipline



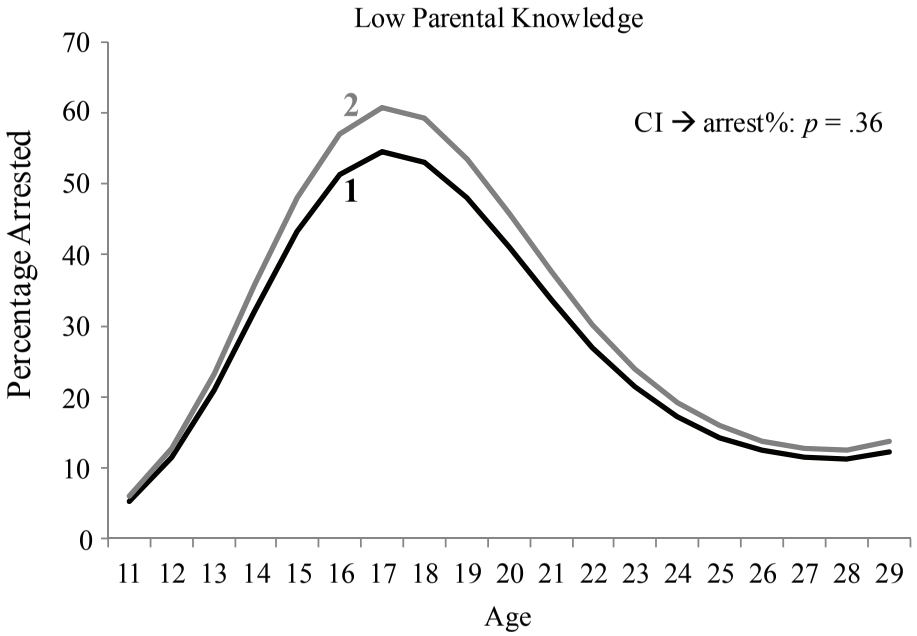



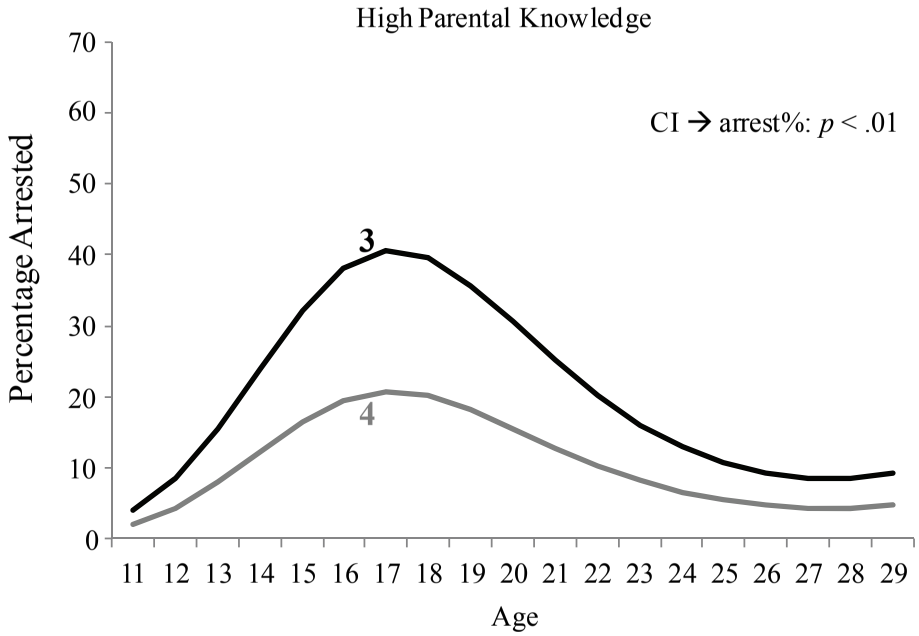

b. Positive Reinforcement



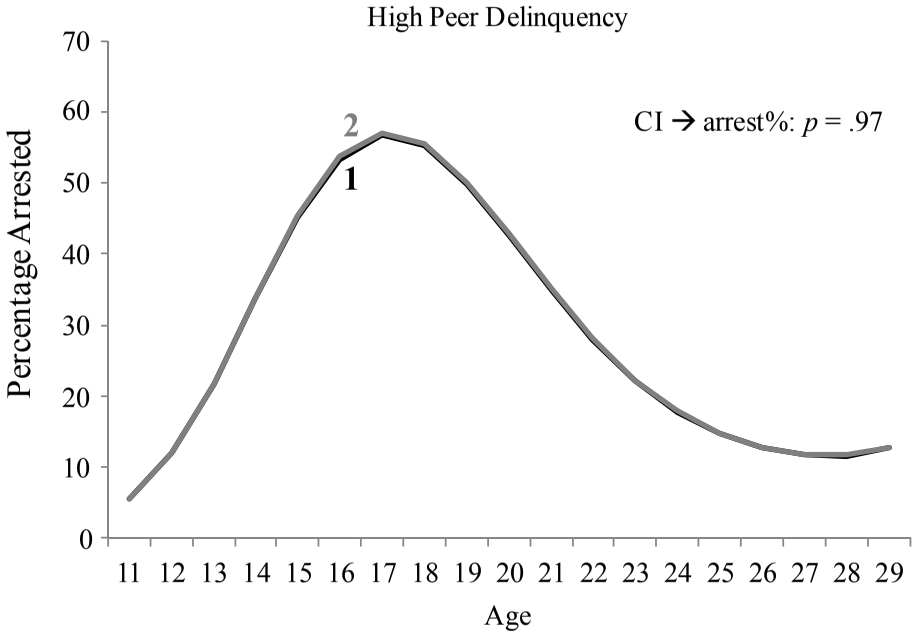



c. Parental Knowledge




d. Peer Delinquency



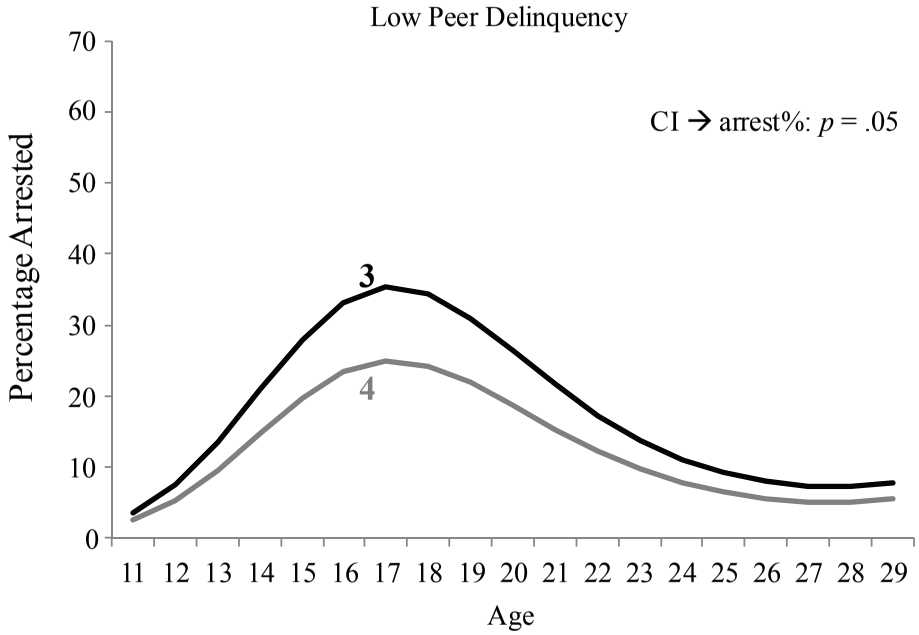



*Figure 5.2*. Estimated age-arrest curves for high (*M* + *SD*; represented by the black lines, curves 1 and 3) vs. low (*M* – *SD*; the grey lines, curves 2 and 4) cognitive impulsivity (CI) in boys with: a. Low (*M* – *SD*; left graph, curves 1 and 2) and high persistence of discipline (*M* + *SD*; right graph, curves 3 and 4); b. Low (*M* – *SD*; left) and high positive reinforcement of parents (*M* + *SD*; right); c. Low (*M* – *SD*; left) and high parental knowledge (*M* + *SD*; right); and d. High (*M* + *SD*; left) and low (*M* – *SD*; right) peer delinquency. *p* values are reported for CI as predictor of the arrest probability in both the low and high parenting/peer conditions.

## Discussion

This study's aim was to investigate the influence of cognitive impulsivity on delinquency from age 11 to 29 years in the context of parenting behaviors and peer relationships in an at-risk community sample. The course of arrests followed the pattern of the age-crime curve (i.e., peaking around age 17, followed by a decrease; cf. Farrington, 1986). It was found that cognitive impulsivity increased the probability of being arrested, as was found in a previous study in this sample (Loeber et al., in press) and other samples (e.g., Ogilvie et al., 2010).

The goal of this study was to test our hypothesis that the association between cognitive impulsivity and delinquency would be moderated by parenting and peer relational factors. More specifically, the risk of being arrested was expected to be disproportionally higher for cognitively vulnerable boys in an at-risk social environment (or cognitive risk would particularly express itself in an at-risk environment; Lynam et al., 2000; Moffitt, 1993). The results showed that the impact of cognitive impulsivity on delinquency was moderated by parenting behaviors and by peer delinquency. However, the direction of moderation ran counter to our hypothesis. That is, rather than finding that the impact of high cognitive impulsivity was strongest in an at-risk environment, we found that being low on cognitive impulsivity protected against delinquency in the *absence* of social environmental risk. In a low risk environment, low cognitively impulsive boys (those without cognitive vulnerability) were less arrested than high cognitively impulsive boys. In a high-risk social environment, both low and high cognitively impulsive boys had an equal chance of being arrested.

Thus, although we had expected a dual risk (see Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007) type of interaction, the type of interaction that was found is more in line with the social push hypothesis, which suggests that biological factors more likely explain antisocial behavior when there is no predisposing social risk, and that social causes may be more important in an at-risk environment (Mednick, 1977; Raine, 2002). Previous work has supported this type interactions in the link between genetic and environmental factors (e.g., Ouellet-Morin et al., 2008; Tuvblad, Grann, & Lichtenstein, 2006). This does

not mean however that boys in an at-risk environment are never biologically vulnerable. Rather, it suggests that associations between biological risks and antisocial outcomes could be camouflaged in an at-risk social environment (cf. Raine, 2002). Powerful social environmental risks might thus have overshadowed the effect of cognitive impulsivity when boys were in an high-risk environment, which did not happen in low-risk environments.

Our results indeed – though partially – indicated the importance of the social environment, as parental knowledge and peer delinquency were found to be strong predictors of delinquent behavior (i.e., main effects were significant; in line with Deater-Deckard, 2001; Loeber et al., 1986). In addition, good parental knowledge and low peer delinquency predicted lower delinquency in all boys, including those with high cognitive impulsivity – yet significantly less than in boys with low cognitive impulsivity. Regarding parental knowledge, it has to be taken into account though that the extent to which parents know their son's whereabouts likely also depends on individual characteristics of the son, such as the extent of disclosure (Kerr, Stattin, & Burk, 2010). It may thus be that it was (partially) the son's disclosure that moderated the effect of cognitive impulsivity instead of their parents' behavior resulting in better parental knowledge (making it more an individual effect instead of an environmental effect). However, not all social environmental factors included in this study affected delinquency. In contrast to peer delinquency, affiliation with peers participating in conventional activities did not predict criminal behavior (as a main effect), nor was it found to moderate the effect of cognitive impulsivity on delinquency.

Despite the importance of measures assessing social environmental influences, it would be wrong to conclude that CI is – relatively – unimportant when trying to understand the curve of delinquency. In fact, two of our findings may suggest that when trying to reduce the probability of being delinquent over the adolescence and young adult period, particular attention should be focused on CI. The first finding suggesting this is that good persistence of discipline and positive reinforcement only appeared to reduce delinquency among boys who are low on cognitive impulsivity (i.e., those without cognitive risk). If cognitive impulsivity is high (i.e., risk), neither persistence of discipline, nor positive reinforcement can compensate for this (neuro)cognitive child risk factor. Second, the results on parental knowledge showed that improving parental knowledge can significantly reduce delinquency in all boys. However, the relative reduction in delinquency that could be achieved when improving parental knowledge is smaller than the reduction in delinquency that can be achieved when reducing cognitive impulsivity. These findings thus highlight the significance of cognitive impulsivity, and indicate that, in addition to reducing parental and peer risk, a possibly even more fruitful avenue may be to reduce cognitive impulsivity, for instance through cognitive skills training, as this would decrease the risk of being delinquent even more.

This study has limitations. First, because this study was performed in an at-risk urban male sample, it is unclear whether our findings can be generalized to the broader population

which also includes low risk males, and females. Second, in this study, delinquency was measured with official arrest data. Despite the advantages of official arrests especially in longitudinal research (e.g., continuous recording at fixed time points, no recall errors as with self-reports), arrest data could give an underestimation of actual delinquency because even in a highly effective police and justice system, offences go undetected by law enforcement. This may apply particularly to younger children as the peak of the arrest-curve was found to be later for official data compared with self-reports (Kirk, 2006). Moreover, we did not distinguish between types of offences that lead to the arrests. As different types of offences follow different age-curves (Sampson & Laub, 2003), we do not know whether the effects found in this study relate to all forms of offences, or to specific forms only. Third, cognitive impulsivity was assessed only once in early adolescence, making it impossible to test changes in cognitive impulsivity across development and possible effects of these changes on the course of offending. Although individual differences in cognitive functioning deficits tend to be rather stable over time (Biederman et al., 2007), it would be important to retest our hypothesis with measures of cognitive functioning assessed repeatedly, in order to examine possible temporal interrelations between cognitive functions and delinquency. Similarly, parenting behaviors and peer relationships were measured in late childhood and early adolescence only. Assessments at later ages are necessary to examine whether these social factors (and possible others, because the social environment changes much in adolescence/adulthood, e.g., partner selection/marriage) still moderate the link between cognition and offending. Fourth, this study focused only on boys from late childhood onwards, making it impossible to say anything about the moderating role of parenting/peer relations at earlier ages. As theorized by Moffitt (1993), cognitive vulnerabilities are likely already exacerbated by social environmental risks at very young ages, increasing the chance of antisocial development. Consequently, we do not know whether poor parenting and peer delinquency during late childhood modify the impact of cognitive impulsivity on delinquency development, whether earlier social environmental factors already account for these effects, or whether they have additive effects.

## Conclusion

This study's results show that cognitive impulsivity indeed predicted the probability of offending, but that the strength of this link depended on parenting behaviors and peer relationships. This implies that both individual cognitive and social environmental risks need to be taken into account when investigating offending, and not only as additive main effects. When taking social environmental factors into account as possible moderators, researchers may find stronger effects of cognitive variables on offending, particularly for those young males in a good social environment (cf., Raine, 2002). Similarly, the importance of cognitive skills in the prediction of delinquency may be underestimated in the presence of environmental risks when such risks are not taken into account. Moreover, when focusing on

the prevention of delinquency, it is important to improve cognitive functioning (e.g., by improving inhibition and working memory skills; e.g., Van der Molen, Van Luit, Van der Molen, Klugkist, & Jongmans, 2010), particularly in cognitively impulsive boys. However, our findings also imply that improving cognitive skills will likely not be sufficient when the boy remains in an at-risk social environment. Presumably, it will only be effective when cognitive skill training is combined with parenting programs, aimed at improving disciplinary techniques, increasing positive reinforcement and parental knowledge/supervision, and interventions to prevent affiliation with delinquent peers. Especially focusing on improving parental knowledge and reducing peer delinquency could be effective, as both were found to reduce offending in boys with and without cognitive vulnerability.